P.S. Aksiutenko[1], student
A.V. Kysel[1], student
I.K. Babichev[1], graduate student
[1]**National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"**

SIMULATION OF COMBINED LANDFILLING OF WASTE ROCK AND IRON ORE ENRICHMENT WASTE

Abstract: *According to the results of the simulation of the process of compatible dump formation in Plaxis 3D, models of dump behavior were obtained for 2 options for placing beneficiation waste on them, which allows predicting the stability of artificially created embankments throughout their entire existence.*

The possible storage volumes of enrichment waste have been determined. It was noted that when using a bulldozer dump, it is possible to increase the capacity of the dump by 8,7% without changing its geometric parameters, and when placing waste in trenches, its content in a compatible dump can reach up to 21,9% by volume.

For the considered variants of dump formation, the numerical values of the reserve coefficients of the dump's stability after its construction have been established.

Keywords: *enrichment waste; career; heap; overburden rocks; landfill formation; maximum deformations; stability margin factor.*

Introduction. As a result of beneficiation of iron ores in factories, iron ore concentrate and waste (so-called "tails") are obtained. These beneficiation wastes are sent to a tailings facility for further storage. In recent years, the problem of storing enrichment "tails" has become more and more urgent, since additional areas of land are needed for tailings storage. Therefore, researchers face the issue of developing new and/or improving existing methods of placing and storing enrichment waste in order to maximize the capacity of existing and newly designed sites for the storage of enrichment waste [1-3].

One of the ways to minimize the area for storage of beneficiation waste is to locate it on waste rock dumps. This can be implemented using two options:

– by mixing waste with overburden, using bulldozer dump formation;

– by separately backfilling enrichment "tails" in the trench formed on the overburden dump.

Domestic and international experience shows that the combined location of beneficiation production waste and waste rock in landfills is most effective only in a dry state.

In this regard, the optimization of the parameters of the combined dumping of overburden and beneficiation "tails" in the specific conditions of the mining enterprise is important.

Purpose and tasks. Taking into account the relevance of the issue of placement of beneficiation waste, the purpose of this article is to establish the possibility of joint waste rock formation and iron ore "tails" by modeling this process.

The task of the research should be to determine the numerical values of the coefficient of stability of the combined dump after its formation.

Material and research results. To solve the problem of storage of beneficiation waste at the Poltava mining and beneficiation plant, it is recommended to store waste in a dry state with a relative humidity of the storage material of 10-15% [4,5]. Despite some disadvantages of dry storage of enrichment "tails", this method is the easiest to implement and to some extent solves the problem of the lack of tailings storage facilities.

Modeling of the behavior of a combined dump during its formation, when waste from beneficiation factories is placed in it, was performed in the Plaxis 3D software complex [6]. The task of the modeling was to determine the coefficient of the reserve stability of the dump and establish the permissible deformations that occur during its construction. Based on the Coulomb-Mohr strength theory, the deformations of the artificial rock embankment, namely, the dump, and the degree of its stability were established using the finite element method.

The initial data for modeling are the basic physical and mechanical properties of the waste rock and enrichment "tails" and the design parameters of the waste (Table 1).

Table 1 – Design parameters of the dump

№	Basic parameters	Dimensionality	Indexes
1	The existing number of dump tiers	units	3
2	Markings of the horizons of the tiers	m	+70,0; +88,0; +108,0
3	The number of dump tiers according to the project	unit	11
4	The final mark of the design dump	m	+268,0
5	The average height of the project tiers	m	20,0
6	The angle of non-working dump slope	degrees	30-35
7	The width of the inter-storey terraces on the dump	m	50,0-80,0

Based on the results of simulation of the proposed options for dumping overburden and beneficiation production waste, models of joint dump formation after the construction of the dump were obtained [7]. Fig. 1 presents a geomechanical model after the formation of a dump when the mining mass is dumped by a bulldozer down the slope, and Fig. 2 shows a geomechanical model after the placement of beneficiation waste in a trench.

The modeling of the dump formation process was carried out in stages, starting with the construction of the 4th tier, because the 3 lower tiers already exist.

Fig.3 shows the development of deformation processes that occur during joint dump formation as tiers are formed, for 2 variants of joint dump formation [8, 9].

Conclusions. Based on the results of the simulation of the process of compatible waste disposal in Plaxis 3D, models were obtained for 2 options for the placement of beneficiation waste on the quarry dump. These models make it possible to predict the behavior of the dump throughout its lifetime.

The estimated volumes of enrichment waste storage are established and it is indicated that when using a bulldozer dump, the capacity of the dump can be increased by 8,7% without changing its geometric dimensions. When waste is placed in trenches, its content in the total volume of a compatible dump can reach up to 21,9%.

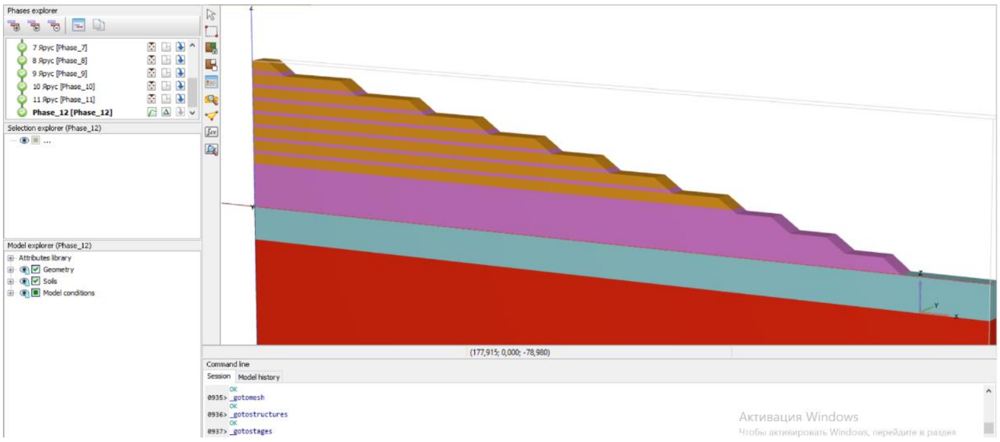

Fig. 1. Geomechanical model of a combined dump during bulldozer dumping

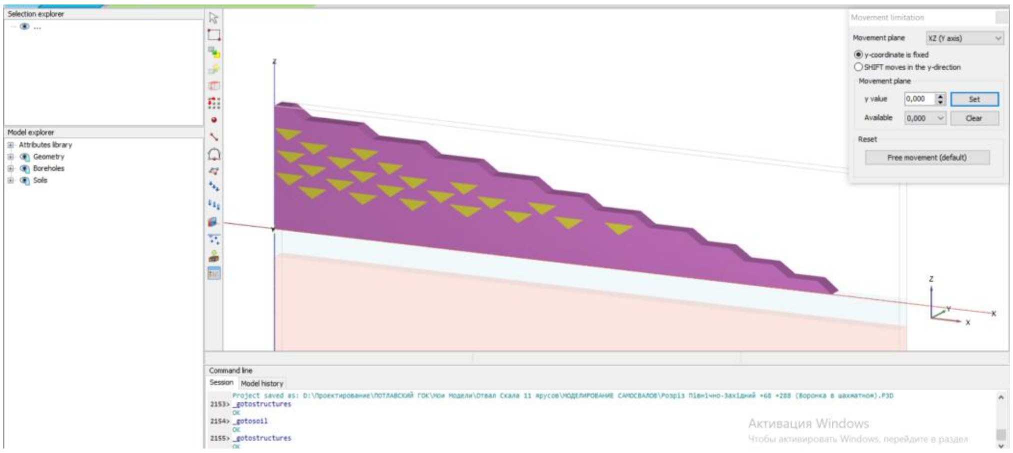

Fig. 2. A model of a combined dump during dumping of beneficiation waste in a trench

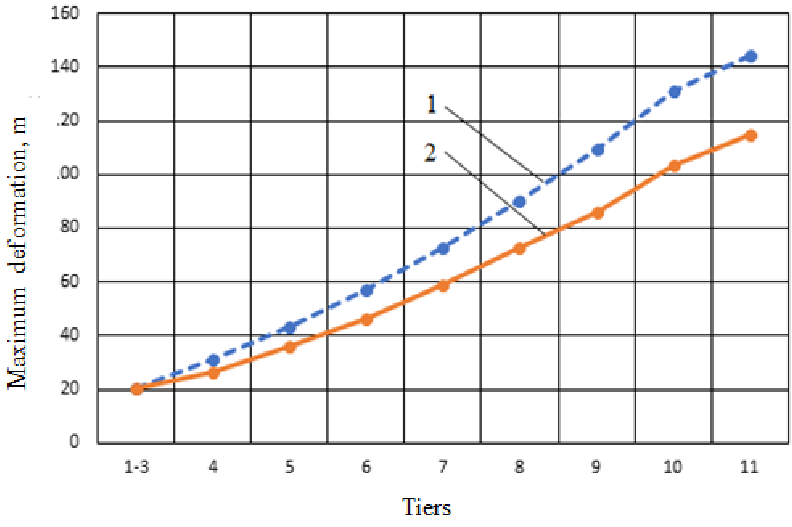

Fig. 3. An increase in the maximum deformations of the dump as the tiers increase: 1 – during bulldozer dumping; 2 – when placing enrichment "tails" in the trench

In addition, for the considered options of dump formation, the numerical values of the reserve coefficient of dump stability after its formation were determined. It was established that their calculated values exceed the minimum permissible n=3 according to the current norms. Thus, the value of the coefficient of stability of a compatible dump during bulldozer dump formation is 1.325, and when dumping enrichment waste in a trench is 1.329.

Therefore, the formation of a combined dump from overburden rocks and waste from the production of the beneficiation factory according to the indicated options for tailings is possible and expedient. The choice of the most effective option of waste disposal should be justified by economic calculation.

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Scientific advisor: **O.O. Frolov**, Dr. of Engineering, Prof.,

П.С. Аксютенко[1], студент
А.В. Кисель[1], студент
І.В. Бабичев[1], студент випускник
[1]Національний технічний університет України
«Київський політехнічний інститут імені Ігоря Сікорського»

МОДЕЛЮВАННЯ КОМБІНОВАНОГО ЗАХОВАННЯ ПУСТИХ ПОРІД ТА ВІДХОДІВ ЗБАГАЧЕННЯ ЗАЛІЗНОЇ РУДИ

Анотація: *За результатами моделювання процесу сумісного відвалоутворення в Plaxis 3D отримано моделі поведінки відвалів для 2-х варіантів розміщення на них відходів збагачення, що дозволяє спрогнозувати стійкість штучно створених насипів впродовж усього терміну їх існування.*

Визначено можливі обсяги складування відходів збагачення. Відмічено, що при використанні бульдозерного відвалоутворення можливе підвищення місткості відвалу на 8,7% без зміни його геометричних параметрів, а при розміщенні відходів у траншеях, їх вміст у сумісному відвалі може досягати до 21,9% за об'ємом.

Для розглянутих варіантів відвалоутворення, встановлені чисельні значення коефіцієнтів запасу стійкості відвалу після його спорудження.

Ключові слова: *відходи збагачення; кар'єр; відвал; породи розкриву; відвалоутворення; максимальні деформації; коефіцієнт запасу стійкості.*